Knight Foundry

Water Powered Foundry & Machine Shop—Since 1873

Ed Arata

California's mining industry played a major role developing hydro-power generation in the United States. Hard-rock miners during the late 1800s thrust themselves to the forefront of mining technology, facing new and unique problems extracting the mineral wealth of the Mother Lode. One of their key needs was to develop a water power source matching the resources to the demands of their mining activities. Early operations relied on known water wheel technologies, such as the overshot, the undershot, and breast designs. These proved too inefficient for the power needs and water conditions of the region. Steep topography and limited water flow during part of the year encouraged millwrights to develop a wooden, high pressure water wheel or "hurdy-gurdy." The first cast-iron, tangential water wheels evolved from the early designs developed by grass-roots engineers in the foothill gold camps, such as Nicholas Colman, D. Donnelly, Lester Pelton, and Samuel Knight.

Knight Foundry

The Knight Foundry was established in 1873 (possibly as early as 1871) originally as the Campbell, Hall & Co., to better meet the ever-expanding needs of the Mother Lode mines and to produce the patented Knight water wheel. Samuel Knight, a partner with Campbell and Hall at the beginning of their foundry venture, later bought them out with his new partner George Horne. Knight, a ships carpenter, worked at mine construction sites in Calaveras and Amador counties, where he began to develop a more efficient water wheel.

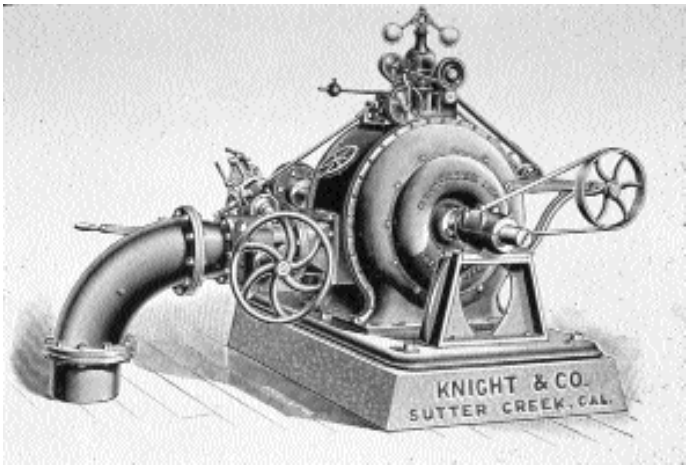
Knight Foundry is the historic site that produces the castings required to keep other restorations and historic sites up and running.

The Knight Catalog of 1896 gives a brief history of Knight's work:

"About 1866, Mr. Knight, in common with others, made water wheels entirely out of wood. The buckets were shaped like saw teeth, and wooden flanges covered the sides of the bucket to confine the water; a round nozzle was used and the general results were considered at the time highly satisfactory.

"The next step (1868) was to make a wooden water wheel with iron buckets, giving them a curve and discharging the water toward the center of the wheel, still using a round nozzle.

"In 1870 a man named Colman patented a wheel which had a bucket shaped very much like that of the present Pelton Bucket, the stream splitting and curving off to each side. He, for lack of means, did not develop the idea.



Turbine for generator. Graphic from the Knight catalog, c. 1896. Courtesy Knight Collection, Jackson, CA.

"Mr. Knight made several improvements in 1872 by using a curved iron bucket and having the discharge towards the center and to one side. Knight also found that the round nozzle did not fill general requirements, from these water wheels sprang the present Knight Wheel.

"In 1875, the first wheel of present design was placed at the Lincoln Mine at Sutter Creek, and from that time various improvements have been made in the size and arrangement of the slits in the nozzle and shape of the buckets, until at this present time, Mr. Knight is manufacturing a wheel that, for general utility and economy, challenges competition."

As indicated, Knight's work over a number of years led to his patenting of a cast iron, high speed, water wheel which became the forerunner of the Pelton Wheel.

Knight's Water Wheel catalogs of the 1880s and 90s show that more than 300 wheels had been produced and were in wide use all over the western United States and some had even been exported. It was claimed that Knight wheels were being used to power over 2,000 stamps in quartz mills. Knight also produced a water "motor" which was a small water wheel enclosed in a cast iron housing, ready to be attached to a high pressure water source. These water motors were very popular and, prior to the advent of electric motors were used to run numerous applications. Water motors came in four sizes: 6", 12",18" and 24."

After 1883, the Knight Water Wheel experienced heavy competition from the Pelton Water Wheel. Although Knight had been the acknowledged leader, Lester Pelton's design was being tried in northern mines of the Mother Lode; some felt it was a better design. In 1883, the Idaho mine in Grass Valley decided to try to settle the issue by inviting Knight, Pelton, and two other wheel producers to Grass Valley to conduct tests of comparable wheels. During these trials, Pelton's design proved the most efficient, winning the contract to supply wheels to the Idaho mine. The Pelton Water Wheel Company went on to become the leading producer of impulse type wheels, eventually moving its operation to San Francisco.

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Knight continued to produce wheels into the early 1900s. Complete wheel and governor sets were supplied to some of the first hydroelectric plants in the western U.S. Among these were the White River project in Oregon, the Pioneer Electric Power Company in Ogden, Utah, and the Power, Transit and Light Company of Bakersfield in the early 1900s.

Although it was no longer the prime producer of water wheels, Knight & Co. continued to flourish in the late 1800s and early 1900s as an innovative manufacturer of mining equipment, hydraulically activated dredger buckets, dredger pumps, hydraulic engines, speed governors, and hoisting works. Knight & Co. held U.S. Patents for seven different pieces of machinery designed and produced in their shops.

For 50 years from the early 1900s to mid 1950s, the foundry continued producing mining equipment for the now famous gold mines of the Mother Lode, but it also became instrumental in the production of machinery for the timber and lumber industries. Knight's Foundry supplied some of the original equipment installed in the saw mills of the central California foothills and later replacement parts and repair facilities. Knight Foundry has counted most of the major lumber and timber operations in northern and central California among its customers, along with (in more recent years) clay, sand, gravel, and gold dredging operations.

Over the past 20 years, as well as supplying new and replacement equipment to the mining and timber industries, Knight has produced machine parts for other manufacturers of pumps and agricultural equipment. It has also produced reproduction architectural iron work for the California state capital building restoration and for restoration projects in Old Sacramento.

Knight Foundry Today

Knight Foundry continues to function as the last water-powered foundry and machine shop in the United States. Still using the 42" diameter wheel installed by Samuel Knight in the 1870s, the machine shop is powered by water falling over 400' from the ridge above Sutter Creek. The Tanner Reservoir which supplies water to Knight Foundry was built in the late 1870s as part of the Amador Canal to supply water power to the mines of central Amador County. The Amador Canal, through a system of wooden flumes, ditches and man-made lakes, carried water over 50 miles from the Mokelumne River to ensure a dependable year round power supply. Apart from the main water wheel, small wheels throughout the site operate other pieces of machinery. A 24" wheel drives the air compressor and was originally used to power the blower for the air supply to the furnace in the foundry room. Two 12" water motors power lathes and the table saw in the pattern shop. An 18" motor powers the planer in the machine shop. A 12" motor drives the grinder in the foundry; and others run the tumbler, the clay processing mill, the hoist for the drop ball, and the firewood table saw.

Foundry & Machine Shop, Knight Foundry, Sutter Creek, CA. Courtesy Knight Collection, Jackson, CA.

Casting iron, Knight Foundry. Photo by Carolyn Fox, Jackson, CA.

Knight Foundry is believed to be the only water-powered foundry and machine shop in the U.S. and has been in continuous operation since 1873. Our site is listed on the National Register of Historic Places, is designated as a California Historical Landmark, and has recently been designated a historic site by the American Society of Mechanical Engineers (ASME).

Knight Foundry operated as a commercial foundry until 1991, when the owner closed it due to sagging economic conditions. It was reopened in July 1992 by Historic Knight & Co., Ltd. both to keep the foundry operating, and to begin developing historical tourism and education programs related to the site.

Tourism and Education

The site now offers a self-guide tour to visitors on a daily basis. Visitors receive a walking tour guide which leads them through 20 stops along the tour route, explaining the history and operation of the site. Guided group tours are available by reservation. In addition to tours, schools are encouraged to use the site for field trips. Two types of field trips are offered: the first, a two-hour program includes time with a blacksmith; the second, a six-hour program, starts in Jackson and finishes with a tour of Knight Foundry. This program gives students a better grasp of how mines in Amador County operated and why Knight Foundry was needed to supply heavy equipment.

Knight Foundry has developed a three-day "hands-on" workshop for adults. The Industrial Living History Workshop, advertised nationwide, has been well received. Students actually work in the foundry, machine shop, blacksmith shop, and pattern shops to learn the skills of the late 1800s. The class regularly has 21 to 28 students, assembled into groups of seven. At each work station students receive a brief introduction to the craft and are then given an opportunity to practice these hand skills under the direction of experienced instructors. Students are encouraged to bring foundry projects with them; these may be molded and cast as part of the workshop. In the foundry, students receive instruction in the basic skills of green-sand molding; they then are allowed to mold several items. In the machine shop, students are introduced to water-powered machine tools and then given an opportunity to operate the lathes, planers, and radial-arm drill press. The blacksmith portion gives students the chance to do some forge work while producing several items. Students learn the basics of pattern making in the pattern shop and finally are shown how the cupola furnace is prepped and fired for a melting operation. During the final session, those students who wish to participate may also step in with the foundry staff to pour some iron castings.

During recent workshops, students from all walks of life have come to Sutter Creek to experience turn-of-the-century technology. Several participants have produced castings that they will use in restoration projects. In June 1994, Jon Mulholland from the NPS San Francisco Maritime Museum took the class and was able to produce rudder pins for the ferryboat *Eureka*, to replace an original 100-year old pin that was lost. Commenting on the Foundry, Jon said: "Using traditional methods lends authenticity. This is our only option for reproducing historic castings. They have a full pattern shop and machine shop … there is no other resource to duplicate these patterns." Past students have returned home and produced foundry patterns from which the Foundry then produced castings. Some of these included parts for a Shay locomotive restoration project and the tailstock for an antique lathe. Other projects of the Foundry included fire box grates for a Case steam engine, exhaust manifolds for a 1936 Packard, assorted gas engine parts, printing press parts, and weights for an 18th-century French clock. Finally, one of their yearly customers is an excursion railroad near Yosemite. They run an old Shay locomotive and cars on a section of logging track in the foothills of the Sierra Nevadas. The track is very steep and crooked so they go through lots of brake shoes. The Foundry supplies them about 24 brake shoes each spring.

A non-profit organization, Friends of Knight Foundry has also been formed to assist with the preservation and educational programs associated with the site. They have begun to develop a long-range plan for acquiring, operating and preserving the site; and to begin fund raising activities.

Ed Arata is the manager of Historic Knight Foundry in Sutter Creek, CA. For more information, you may call Mr. Arata at 209-267-5543.

Current Issues in Archeological Protection for the Department of Justice

The statement that follows was presented to the Interagency Archeological Protection Working Group (IAPWG) on February 7, 1994, by Jo Ann Harris, Assistant Attorney General, Criminal Division, United States Department of Justice. IAPWG is an informal headquarters-level organization representing federal agency chief law enforcement officers, departmental solicitors, and the appropriate divisions with the Department of Justice. IAPWG meets periodically to exchange information, identify needs, and implement programs and actions to improve archeological resources protection nationwide. This recent IAPWG meeting was held in the National Park Service Director's Conference Room at the Department of the Interior, and Ms. Harris was introduced by Jerry Rogers, Associate Director for Cultural Resources, National Park Service.

Thank you, Mr. Rogers, for your very gracious remarks. It is my pleasure to provide some brief comments on an area in which I have both a professional and personal interest—"Current issues in archeological protection for the Department of Justice." Indeed, this is probably the first time ever that the Assistant Attorney General for the Criminal Division has a history of literally digging in the dirt with a bunch of wonderful archeologists both in the United States and the far reaches of Siberia. My interest: Prehistoric North America.

This is an exciting time for all of us who are concerned about the protection of the richly varied archeological resources which constitute part of the treasure of our history and pre-history in the United States.

Since the enactment of the Archeological Resources Protection Act of 1979 (ARPA), 16 U.S.C. § 470aa et seq., and the recent enactment of the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA), a portion of which is codified as the Illegal Trafficking in Native American Human Remains and Cultural Items Act, 18 U.S.C. § 1170, we now have tools which, if utilized properly—in a criminal, civil or administrative context—or some combination thereof, can be an effective deterrent in preventing further destruction of our archeological and cultural resources.

On January 18, 1994, the United States Supreme Court denied certiorari in an important case construing a key provision of the Archeological Resources Protection Act. In *United States v. Gerber*[1], Judge Posner of the Seventh Circuit Court of Appeals held, for a unanimous court, that section **470ee(c)** of ARPA was **not** limited to archeological objects removed from federal and Indian lands but that it also applied, in certain circumstances, to the removal of archeological resources from private property without the owner's permission. In *Gerber* the "Indian relic" predators, without permission, entered upon land in Indiana owned by the General Electric Company and,

(***Harris***—*continued on page 34)*